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Training Lessons Learned from Peak Performance Episodes

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Basic Research

U. S. Army

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An examination of episodes of peak performance indicates that three cognitive components enable these episodes: psychological readiness (activating optimal arousal and emotion appropriate for the task), information processing (attending to and interpreting key stimuli), and endurance management (controlling fatigue and pain for sustained performance). There is also evidence suggesting that endorphins underlie these three processes. Accordingly, performance can be enhanced through two strategies; one technique is teaching
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self-regulation of endorphin levels. The other more immediately available solution is to use contemporary sports psychology training techniques to optimize cognitive processes underlying superior performance. With either strategy, optimal performance will result from an enhanced ability to cope specifically and continuously tailored to meet the conditions and demands of a particular activity.

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Training Lessons Learned from Peak Performance Episodes

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FOREWORD

The Army Research Institute is seeking new ways to enhance performance as emphasized by the Army Science Board Subgroup on Emerging Human Technologies. This report describes a promising approach based upon the results of an examination of instances of exceptional military and sports achievement. Psychological components found to be important for optimal performance can be manipulated, with training techniques from sports psychology, such that they are specifically and continuously tailored to meet the conditions and demands of military tasks. This approach to training has major implications for optimizing both individual and team performance.

EDGAR M. JOHNSON
Technical Director

TRAINING LESSONS LEARNED FROM PEAK PERFORMANCE EPISODES

EXECUTIVE SUMMARY

Requirement:

High quality performance will be essential to prevail on the battlefield envisioned for the 21st Century. Consequently, a major challenge confronting US Army readiness is obtaining optimal performance from both its human and machine resources. Force modernization towards ARMY 21 has benefited greatly from R&D on equipment technologies. Comparable R&D efforts are needed to obtain breakthroughs for optimizing individual and group performance. This requirement can be met in part through an understanding of performance regulation and related training technologies that can enhance Army performance.

Procedure:

The training concept described here is derived from an examination of instances of exceptional achievement - peak performances. Factors accompanying episodes of peak performance in soldiers and athletes were identified through two major sources. Information was obtained from literature reviews of data bases dealing with peak performance in the military, sports psychology/medicine, and biological sciences as well as from interviews conducted with athletes and members of the military.

Findings:

The examination of episodes of peak performance indicates that three cognitive components enable these episodes: psychological readiness, information processing, and endurance management. There is also evidence indicating that endorphins underlie these processes. Accordingly, performance can be enhanced through two strategies; one approach for future development is teaching self-regulation of endorphin levels. The other more immediately available solution is to use contemporary sports psychology training techniques to optimize the psychological processes underlying superior performance. With either strategy, superior performance will result from an enhanced cognitive ability to cope that is specifically and continuously tailored to meet the conditions and demands of particular activities.

Utilization of Findings:

This report identifies the scientific basis for several training strategies that can be developed for enhanced Army performance. These training approaches will help to meet the ARMY 21 goal to accomplish more with less manpower.

TRAINING LESSONS LEARNED FROM PEAK PERFORMANCE EPISODES

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TRAINING LESSONS LEARNED FROM PEAK PERFORMANCE EPISODES

INTRODUCTION

A major challenge confronting the US Army is to obtain optimal performance from both its' human and machine resources. Force modernization has benefited greatly from R&D on equipment technologies. Comparable R&D efforts are needed to obtain training breakthroughs for optimizing individual and team performance. The general approach undertaken here accordingly emphasizes investigations of a neglected aspect of technology - human technologies - as stressed by the Army Science Board Subgroup on Emerging Human Technologies (Blanchard, Clark, Sidwell, Ley, Jr., & Weddle, 1983). The impetus for the training concepts described here derives from an examination of instances of exceptional achievement - peak performances. Factors accompanying such performance episodes in soldiers and athletes were identified through two major sources. Information was obtained from literature reviews of data bases dealing with peak performance issues in the military, sport sciences/medicine, and biological sciences as well as interviews conducted with athletes and members of the military.

The general public views world-class athletes as physical supermen and superwomen. Athletes themselves frequently remark that as much as 90% of their competitive edge and success is attributable to "mental factors". The importance of

psychological influences on performance was not lost on Bruce Jenner: "I always felt that my greatest asset was not my physical ability, it was my mental ability" (Garfield & Bennett, 1984). Despite athletes' belief in the importance of psychological processes, the overwhelming proportion of American research on sports concentrates on other factors. However, the tendency to disregard psychological variables is being reversed with the emergence of the field of sports psychology. During the past two decades, this discipline has promoted general interest in the neglected psychological concomitants of performance.

Current research offers the intriguing prospect that soldiers and leaders can train to perform mental and physical feats vastly superior to the norm. Peak performances, usually associated with elite athletes, are experienced by almost everyone at some time. Such performance episodes seem to occur most frequently in competitive sports, because of the emphasis on striving for excellence where performance quality is indicated by objective measures. Top performers frequently report that attaining truely exceptional levels of performance depends upon their mental state. Some believe that peak performance episodes result from being in a special or "altered state" of consciousness which can not be deliberately or voluntarily evoked.

Unfortunately, the sports psychology literature is predominantly theoretical in terms of psychological processes

contributing to performance. Techniques for the psychological enhancement of performance accordingly lack the organization and integration that can ensue from a theoretical account. Many related training interventions are instead driven by trial-and-error and represent more of an art form than application of scientific principles. The theory of peak performance presented here includes psychological factors which are susceptible to self-regulation. Guidance is also provided about the circumstances under which these psychological factors need to be modified.

AN ALTERED PERCEPTION SYNDROME

The sports psychology and military literature (Browne & Mahoney, 1984; Epuran, 1978; Hickman, 1979; Marshall, 1947; Murphy & White, 1978; Privette, 1981), as well as interviews with athletes (Unesthal, 1982) and the military (Goldman & Fuller, 1983; Marshall, 1967, 1967; Sullivan, 1984; 1985), indicate, surprisingly, that performance is frequently at its best during episodes which include marked perceptual alterations. Changes are initially moderate and frequently beneficial, reflecting focused attention as well as factors related to strength. Progressing further along this dimension of altered perception results in increasing distortion that can be counterproductive to optimal performance. This altered perception syndrome ranges along a continuum through impressions of: altered attention/concentration - slowed passage of time - objects

appearing larger - detachment and control - reduced fatigue/pain - exceptional energy or strength - serenity - invincibility - psychokinetic or telepathic sensations - out of body sensations.

Partial amnesia also commonly occurs for peak performance episodes, as exemplified by reports that "After a very good jump, I remember nothing from the moment I'm about to leave. My memory returns just before I touch down. If, however, I have had a bad jump, I remember clearly the entire jump" (ski jumper) (Unesthal, 1982). Amnesia is unfortunate here because of its' negative consequences for interviewing performers about their mental control. Both this amnesia and the perceptual distortions emphasize the importance of psychobiological contributions for understanding peak performance regulation.

A satisfactory theory of peak performance must encompass both the exceptional level of performance exhibited and correlated perceptual and memory phenomena. This review conceptualizes the psychological processes involved in both superior performance and the associated altered perception syndrome. These psychological contributions to peak performance are based upon three highly interactive and ongoing processes: psychological readiness, information processing, and endurance management.

PSYCHOLOGICAL PROCESSES

Psychological Readiness - Arousal and Affect

Psychological regulation of performance quality begins with a foundation of cognitive preparedness to meet task conditions. This readiness consists of having an appropriate level of both arousal (psyched-up or -down) and affect (emotions and attitudes). The optimal activation level depends upon the nature of the task and activation is frequently related to performance by an inverted U-shaped function. That is, performance is enhanced by increased activation up to some point; beyond this, performance deteriorates (Yerkes & Dodson, 1908).

The relationship between performance quality and optimal activation level also varies with task complexity and other conditions such as a performer's skill level. More complex (or poorly learned) tasks are typically better performed with low activation levels. In contrast, relatively simple (or well learned) tasks can be better performed under high activation. It is important to determine the optimal activation needed, for a particular set of task conditions, because inadequate levels of arousal are associated with poor performance. Excessively high arousal levels are even more debilitating as they can result in confusion, loss of confidence and fear of failure, and an

impaired ability to attend to important cues (Browne & Mahoney, 1984; Landers, 1978). Numerous attempts have been made to regulate athletes' activation levels through auto suggestion. These techniques (e.g., autogenic training, biofeedback, breathing exercises, progressive muscle relaxation) are commonly found to influence activation levels (Hickman, 1979; Sandweiss & Wolf, 1985; Wilson & Bird, 1982).

Information Processing - Perception and Memory

Optimal performance requires an ongoing collection of information about task conditions. This material is then processed, compared with memories of relevant experiences, and a course of action is chosen. Ongoing responding is then modified, as appropriate, in a continuous feedback loop. This information extraction and comparison process in decision making begins with the vast amount of material in short-term sensory storage. Orientation and selective attention reduce this overwhelming amount of material into that transferred to short-term memory. Information is then assessed and interpreted in this cognitive workspace. Processing includes interacting with long-term memory to attach meaning to sensory input and to select from the stored repertoire of response patterns.

For an individual who is psychologically ready to respond, awareness must focus on critical triggering cues. These include information about both internal (e.g., body condition and

positioning) and external factors (e.g., particular aspects of task conditions) which experience has shown to be essential for good performance. Concentration enhances critical task components and elite performers report being "Completely concentrated on what I am doing. Oblivious to the surroundings" (swimmer) (Unestahl, 1982). This intense selective attention can result in feelings of dissociation from nonessential factors. Soldiers report that "I felt the presence of other beings on the right and left of me, but my intense concentration ... made it impossible to see them" (Sullivan, 1984). At the extreme, performing as if in a 'trance' is experienced. For example, "When I think back on my Olympic race, I remember mainly what I saw on the videotape afterwards. It was a perfect race. I was as if in a trance" (swimmer)(Unestahl, 1982). This is variously called having a hot night (basketball), playing out of one's head (tennis), skying out of one's mind, or losing onesself in jogging and swimming.

Intense concentration can also be accompanied by particularly striking alterations in the perception of time and space. Time appears to advance very slowly during peak performance episodes and reports of behaving in "slow motion" are common from soldiers and athletes. A soldier reported that the point man "was outside time; it was as if the bullets took two or three minutes in flight, and he was watching them." (Goldman & Fuller, 1983). Similarly, "Sometimes everything slows down, which

makes it possible to make moves that normally would have been impossible" (Formula 1 driver) and "Sometimes I can experience my performance as a dance on a film shown in slow motion" (figureskater)(Unestahl, 1982). Spatial distortions are less common and typically involve perceptual enlargement of critical objects in the environment. For example, reports that: "the pigeons become very big and slow" (marksman)(Unestahl, 1982).

Formal sports psychology approaches to optimizing decision making emphasize the long-term memory aspect of the perceptual axis. In addition to enhancing basic skills through traditional practice sessions, preparation has recently been extended to include cognitive rehearsal or imagery. This training procedure consists of rehearsing by thinking about conducting the various performance components. Forming mental images and anticipating emotional responses can also be included and mental rehearsal is particularly appropriate for tasks high in symbolic or cognitive elements (Feltz & Landers, 1983).

Endurance Management - Fatigue and Pain

Supression of fatigue and pain sensations is necessary to sustain performance. Numerous reports indicate increased tolerance of and/or decreased awareness of fatigue and pain for a variety of circumstances including injuries received in military actions and competitive sports (Henry, 1982). Feelings of well-being, and an absence of fatigue or pain even under

strenuous conditions which may result in bodily injury, are commonly reported. Such experiences include soldier reports that "then ... stripped the man's jump jacket away and found six bullet holes in his upper right arm and shoulder; the soldier had not been aware of his wounds until that moment" (Marshall, 1947). Athletes also report such endurance management, "Everything felt terrific" (runner) and that "The body was working by itself without effort and without any feelings of fatigue or pain" (skier)(Unestahl, 1982).

Endurance is typically approached only in terms of physical conditioning and few training regimens attempt to manipulate psychological processes for endurance management. One approach is to ignore fatigue and pain by distracting attention away from these sensations (Broad, 1979). A more formal technique is incorporated in the psychical self-regulation program developed in Russia. This program uses techniques from numerous training systems (meditation, yoga, hypnosis, autogenic training, martial arts) in the attempt to mentally regulate physiological functioning. Included are procedures purportedly useful for influencing pain threshold and obtaining quick recovery from strenuous competition (Hickman, 1979).

UNDERLYING PHYSIOLOGICAL PROCESSORS

Neural mediation of these three psychological processes is associated with different brain areas. Psychological Readiness

is influenced by several brain regions. The reticular formation/activating system regulates the arousal component of readiness. This region also influences attention, modulates sensory cortical input, and affects muscle tone for response readiness. The richly interconnected forebrain structures of the limbic system regulate affect, the other component of psychological readiness.

Information Processing requirements for peak performance primarily involve perceptual and memory processes. These are substantially influenced by specific limbic structures as well as by sensory processing in cortical projection areas. The amygdaloid and hippocampal limbic structures are highlighted here because of their involvement in perception and memory. For example, the amygdala is implicated in attention/orientation, memory, and emotion (e.g., fear, anxiety). Additionally, it is involved in perceptual distortions such as hallucinations (e.g., impressions of heaviness, floating), illusions of familiarity, and disturbed awareness and confusion (Breathnach, 1980; Halgren, 1982; Saunders, Murray, & Mishkin, 1984). The hippocampus is particularly implicated in memory processes including representational or recognition memory and cognitive spatiotemporal maps. It is also involved in disturbances of recent memory such as the amnestic syndrome (Breathnach, 1980; Oakley, 1981; Pandya & Yeterian, 1984).

Analgesic contributions to Endurance Management of fatigue

and pain have their physiological basis in spinal transmission and cortical projection areas. It is noteworthy that the afferent nociceptive pathway includes projections to both the reticular formation (arousal) and the limbic system (affect).

In sum, in addition to physical capability and basic skills, peak performance:

- Is accompanied by an altered perception syndrome;
- Is modulated by cognitive processes of psychological readiness, information processing, and endurance management;
- Is ultimately regulated by neural areas underlying these critical psychological processes.

A MODEL OF NEURAL REGULATION

The recently discovered endorphins include three families of endogenous opiate-like peptides - enkephalins, endorphins, and dynorphins - that function as transmitters or modulators of neural activity. Endorphin levels are influenced by task conditions through both physical (effort, aversive circumstances) and psychological variables (conditioning, fear, suggestion) (Bolles & Fanselow, 1982; Henry, 1982; Katz & Gormezano, 1979).

Specific endorphin involvement with psychological processes

in performance is indicated by studies of anatomical, pharmacological, and behavioral function. Endorphin distributions are concentrated within brain regions associated with the psychological performance components emphasized here. Endorphins also effect specialized receptors similarly concentrated within these brain regions (Dores, Akil, & Watson, 1984; Feldman & Qu...zer, 1984; Frost et al, 1985; Goodman, Fricker, & Snyder, 1983; Ikeda et al, 1983; La Motte, Snowman, Pert, & Snyder, 1978; Miller & Pickel, 1980; Roberts, Allen, Crow, & Polak, 1983; Rossier & Bloom, 1982; Simantov, Kuhar, Pasternak, & Snyder, 1976; Watson, Khachaturian, Akil, Coy, & Goldstein, 1982). Studies of behavioral effects of endorphins also indicate their importance for psychological processes contributing to performance.

The clearest and most researched endorphin function is an analgesic contribution to endurance management. Afferent pain pathways are richly endowed with endorphins involved in the transmission of pain information (Dores et al, 1984; Prezewlocki, Gramsch, Pasi, & Herz, 1983). Efferent inhibiting systems are thought to block nociceptive information with endorphins (Mense, 1983). The perception of fatigue during exercise is modulated by endogenous opioids (Harber & Sutton, 1984) that also contribute to endurance management through pain suppression mediated by placebo effects (Copolov & Helme, 1983).

Endorphin involvement in information processing includes an

influence on all aspects of the perceptual axis. They mediate attention by gating perceptual information (Bolles & Fanselow, 1982), influencing sensory input at the attention and perception levels (Kovacs & de Wied, 1981). A progressively greater influence is then exerted by endorphins at successively higher levels of sensory information processing in the cortex (Lewis et al, 1981). Strong support also exists for memory being altered by endorphin involvement in the mechanism underlying the modulation of memory storage (McGaugh, Martinez, Jr., Messing, Liang, Jensen, Vasquez, & Rigter, 1982). Endorphins are also involved in regulating arousal level through activity in the limbic and extrapyramidal systems (Thompson, 1984).

Endorphins have been previously implicated in athletics as a potential basis for the "runners' high" (Carr et al, 1981). Studies of this effect report increased blood concentrations in response to both acute and chronic exercise (Harber & Sutton, 1984). The difficulty with this research involves undetermined brain involvement accompanying observed changes in peripheral concentrations. Changes in central endorphin concentrations have also been reported in response to stress (see, for example, Barta & Yashpal, 1981) and the present model is based upon endorphin activity in the central nervous system.

The possibility that changed endorphin levels during peak performance are responsible for the altered perception syndrome is particularly apparent. Opiates are associated with emotional

changes, ranging from a sense of well being to euphoria, that accompany the loss of inhibition and anxiety. Hypnotic trance-like effects are also commonly encountered along with generalized alterations in arousal, attention, perception and memory. Extreme perceptual distortions resulting from opiates include the impression of being dissociated from one's body as well as auditory, olfactory, and visual hallucinations (Carr, 1983; Feldman & Quenzer, 1984; Olson, Olson, Kastin & Coy, 1982; Pickar, Dubois, & Cohen, 1984).

TRAINING TAILORED TO MEET TASK CONDITIONS

What does all of this mean for military training programs? The above characterization of performance modulation depicts superior performance as being enabled by psychological readiness, information processing, and endurance management. There is also evidence suggesting that endorphin activity, in associated neural regions, substantially contributes to these processes. Accordingly, performance can be enhanced through two different approaches. One strategy is teaching self-regulation of endorphin levels. The other much more immediately available solution is to influence important congitive processes through training techniques from sports psychology. With either strategy, optimal performance will result from tailoring capabilities to meet a task's conditions and demands.

The meshing of psychological processes with task conditions

and demands to be met requires an encompasing characterization of task requirements. This can be provided by constructing a taxonomy of the major task variables (e.g., complexity, risk) encountered in various military tasks. Individual tasks would be assessed to determine the relative importance of each variable for that task. Ensuing profiles of the importance of task variables, for each particular activity, would then be matched with psychological contributions needed to optimally accommodate these task variables. Such profiles of optimal cognitive functioning are expected to display considerable overlap across activities. Thus, many tasks could be accommodated by being able to meet a limited number of unique sets of task conditions. This would facilitate generalized approaches to self-regulation; however, profiles are also anticipated to identify unusual training needs.

Table 1

The Relationship between Psychological Processes and Task Conditions

INFANTRY SQUAD TASKS	TASK CONDITIONS			
	Effort[a,c]	Duration[a,c]	Complexity[a,b]	Risk[a,b]
Attack	High	Low	High	High
Defend	Low	Medium	Medium	Low

Note: Task conditions make demands on the cognitive factors of

a: Psychological Readiness

b: Information Processing

c: Endurance Management

These points are illustrated in the hypothetical example depicted in Table 1. Of the two infantry squad tasks, the attack is typically high on effort, complexity, and risk while low on duration. In contrast, the defense can be characterized as lower on effort and risk while medium on duration and complexity. These differing profiles of task conditions are best accommodated by different levels of readiness, information processing, and endurance management. Therefore, preparation and execution for the two tasks must differentially reflect coaching and self-regulation for each cognitive component.

Each task condition in this example must be considered to determine the appropriate level of psychological readiness. In general, high effort tasks, such as attacking, benefit from high activation levels. However, recalling that the optimal activation level varies with task complexity, high complexity and risk conditions for an attack are best accommodated by a lower activation level. A medium level of activation may be a reasonable compromise here. The defense, in contrast, is ideally undertaken with much greater activation to enhance performance under conditions of reduced effort and duration. The medium complexity and lower risk involved can also be better accommodated by higher activation. These two task demand profiles have an obvious implication for interventions influencing psychological readiness. Optimal activation for defending is much higher than for attacking which may require a

reduction in arousal.

Information processing needs are moderate for defending but the complexity and risk involved in attacking require rapid and accurate decision making. The risk condition also necessitates optimizing information processing while perceptual distortions are minimized. Preparation should include cognitive rehearsal for appropriate memory storage of behaviors which can be recalled during mission execution. Finally, the higher effort required in the attack makes endurance management more of a concern in that mission than it is for the defense.

In sum, a theory and model of peak performance is presented which proposes that psychological processes in performance:

- Reflect endorphin activity within underlying physiological processors;
- Need to be tailored to task conditions and demands.

TRAINING PROGRAM DEVELOPMENT

An examination of peak performance episodes indicates critical psychological contributions from: psychological readiness to respond to task conditions/demands, information processing, and endurance management for sustained performance. Activity within brain regions associated with these processes further suggests the importance of endorphins in performance

modulation. Self-regulation training for performance enhancement can accordingly be directed at either the psychological processes or their underlying physiological processors.

Physiological Processors

Considerable basic research is needed to benefit from the endorphin-mediated physiological basis of performance. In general, research is needed to: 1) determine optimal endorphin levels in brain regions supporting cognitive processing, and 2) develop self-regulation procedures to manipulate endorphin levels in a noninvasive manner. Much of this research and development would most appropriately be conducted by an agency with a medical mission, such as the Army Medical R&D Command.

Psychological Processes

Self-regulation of psychological processes can be accomplished in the near-term. Such an effort would start with identifying relevant sports psychology training techniques for self-regulation of the psychological factors emphasized here. This includes coaching procedures and techniques for individual manipulation of psychological readiness (e.g., biofeedback for affecting arousal level), information processing (e.g., cognitive rehearsal to enhance memory), and endurance management (e.g., reduced awareness of fatigue and pain). Sports psychology techniques would also be identified for enhancing group dynamics (e.g., increased motivation from cohesion, attitudes, and values;

enhanced decision making from communication flow aids).

Individual and team military tasks would then be characterized according to their degree of dependence upon each of the three critical cognitive processes. A pilot program of instruction would then be developed for teaching behavioral control within the context of existing military instruction and training. This self-regulation training should be specifically tailored to match psychological processes to task conditions and demands to be met.

In sum, a prototype performance enhancement training program is conceptualized to incorporate:

- A training concept, from the sport sciences, to influence critical psychological processes;
- A training concept, from psychobiology, to influence underlying physiological processors

CONCLUSION

An examination of episodes of peak performance indicates that three cognitive components enable these episodes: psychological readiness (activating optimal arousal and emotion appropriate for the task), information processing (attending to and interpretating key stimuli), and endurance management (controlling fatigue and pain for sustained performance). There is also evidence suggesting that endorphins underlie these psychological processes. Accordingly, performance can be enhanced through two strategies; one approach is teaching self-regulation of endorphin levels. The other more immediately available solution uses contemporary sports psychology training techniques to optimize psychological processes underlying superior performance. With either strategy, optimal performance results from enhanced coping ability specifically and continuously tailored to meet the conditions and demands of a particular activity.

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